



# ***NASA Applied Sciences Program***

## *Overview Presentation*

*Daniel Irwin*

*October 2010*

*Discovering and Demonstrating Innovative and  
Practical Applications of Earth Science*



# **NASA and Earth Science**

## ***Earth Science Division***

NASA is primarily a research and development agency.

The NASA Earth Science Division supports research on the Earth system and its processes. Primary efforts are to characterize, understand, and improve predictions of the Earth system.

In the course of performing its research, NASA collects observations and generates new scientific knowledge that can be applied to meet organizations' decision-making activities.

***Technology***

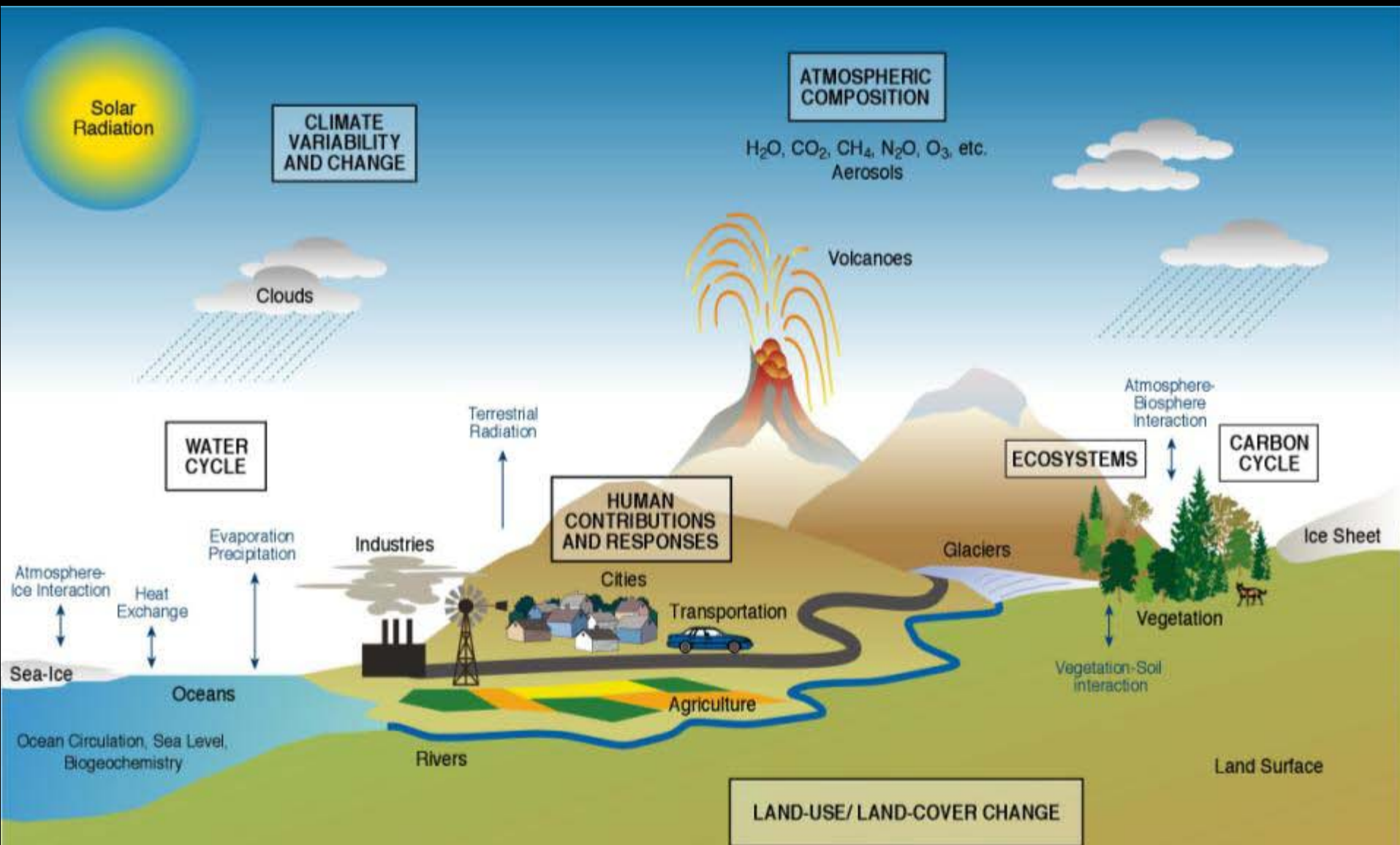
***Missions***

***Research***

***Data Systems***

***Applications***

# NASA Earth System Science

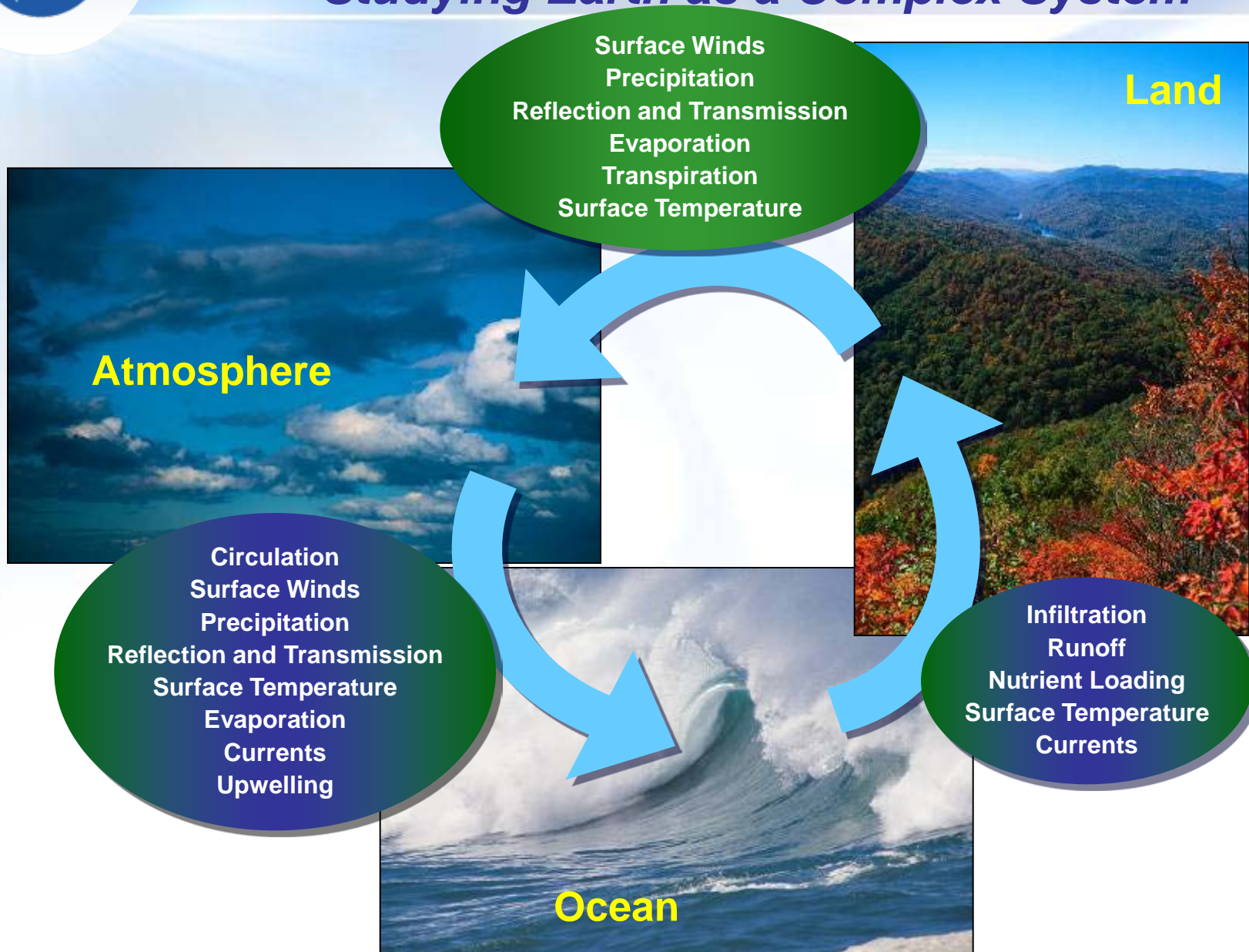






# NASA and Earth Science

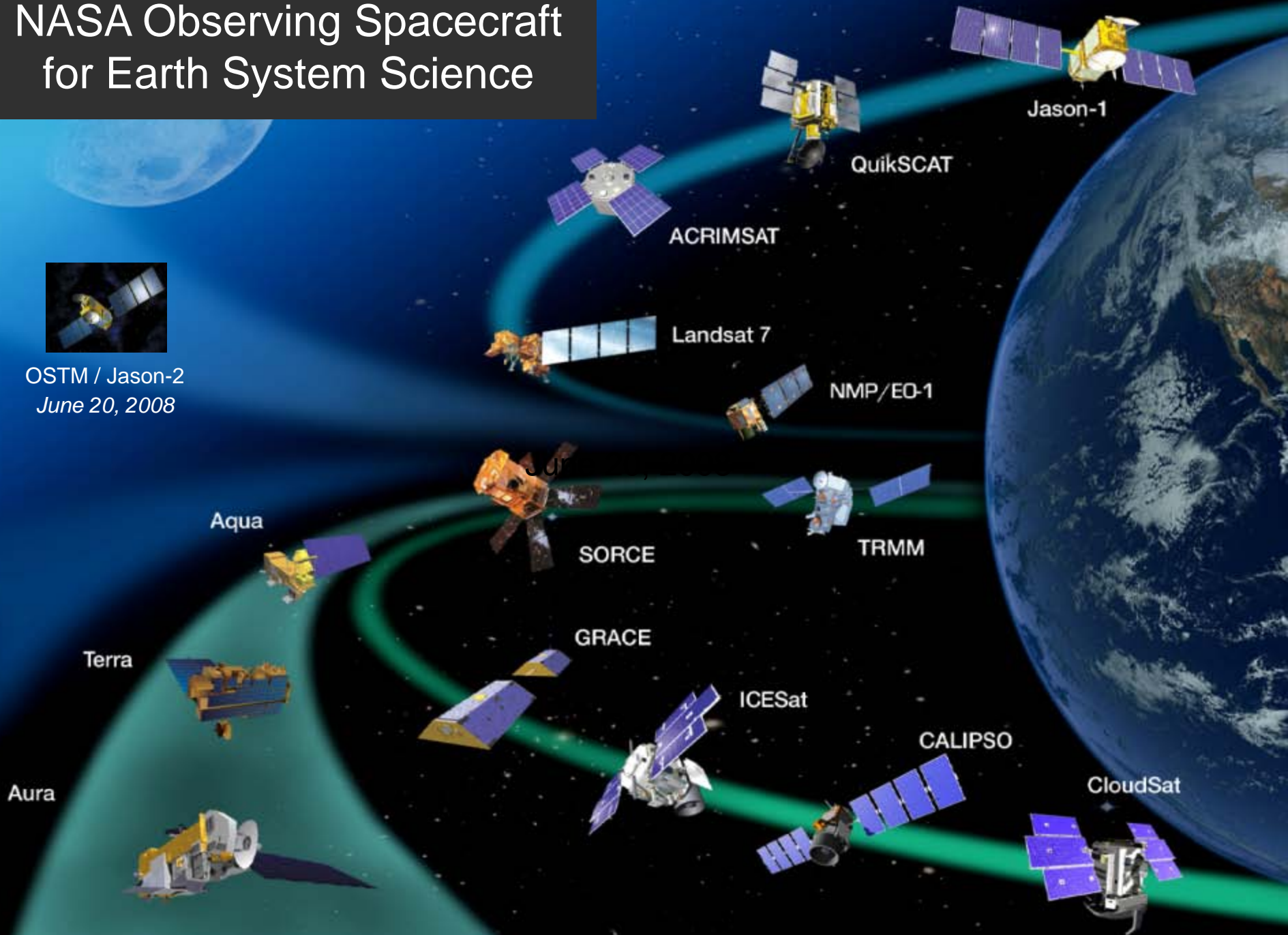
## *Studying Earth as a Complex System*



# NASA Observing Spacecraft for Earth System Science



OSTM / Jason-2  
*June 20, 2008*





# Applied Sciences Program

## *Program Strategy: Goals & Actions*

### **Goal 1: Enhance Applications Research**

Advance the use of NASA Earth science in policy making, resource management and planning, and disaster response.

*Key Actions:* Identify priority needs, conduct applied research to generate innovative applications, and support projects that demonstrate uses of NASA Earth science.

### **Goal 2: Increase Collaboration**

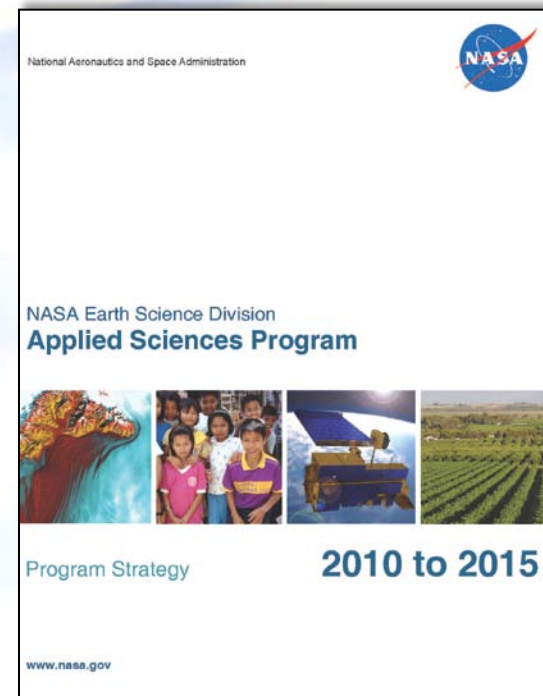
Establish a flexible program structure to meet diverse partner needs and applications objectives.

*Key Actions:* Pursue partnerships to leverage resources and risks and extend the program's reach and impact.

### **Goal 3: Accelerate Applications**

Ensure that NASA's flight missions plan for and support applications goals in conjunction with their science goals, starting with mission planning and extending through the mission life cycle.

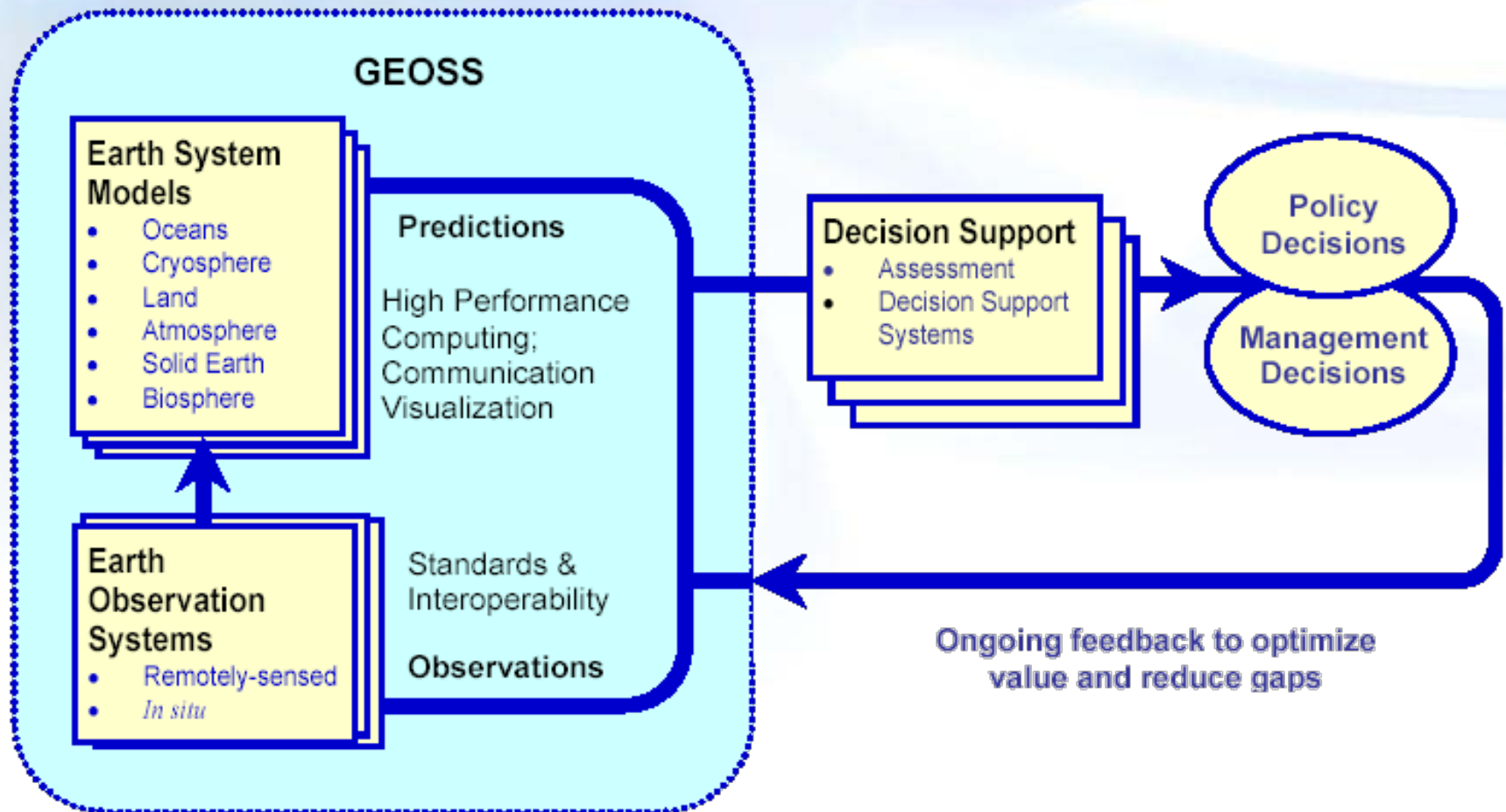
*Key Actions:* Enable identification of applications early in satellite mission lifecycle and facilitate effective ways to integrate end-user needs into satellite mission planning.







# Earth Science for Society





# Applied Sciences Program

## *Applications Areas*

*Applications to Decision Making: Eight Thematic Areas*



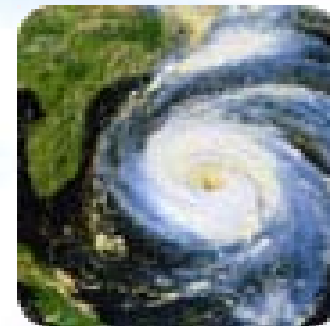
**Agricultural  
Efficiency**



**Air Quality**



**Climate**



**Disaster  
Management**



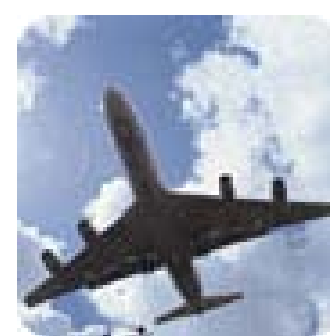
**Ecological  
Forecasting**



**Public Health**



**Water  
Resources**



**Weather  
(Aviation)**





# Applied Sciences Program

## Project Examples

## 2010 Flooding in Pakistan: MODIS & AMSR-E

Robert Brakenridge, Dartmouth Flood Observatory, University of Colorado

- MODIS provided the first mapping of flood inundation and continues to provide excellent regional coverage.
- AMSR-E flood detection display is monitoring the progress of the flood daily without interference by cloud cover.
- AMSR-E river measurement sites are characterizing the daily discharge and flood hydrographs of the event.
- Disaster responders and aid providers include *International Red Cross/Red Crescent*, *World Bank*, *World Food Programme*, and *US military*.
- Data Products are provided via public web site access. Site experienced a peak of 9667 requests/day on August 12, 2010.

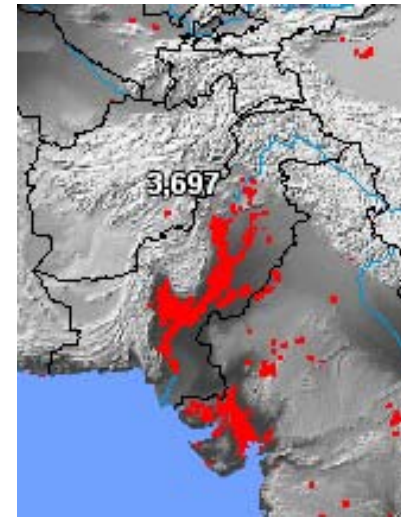


Fig. 1. Portion of global AMSR-E Flood Detection Display

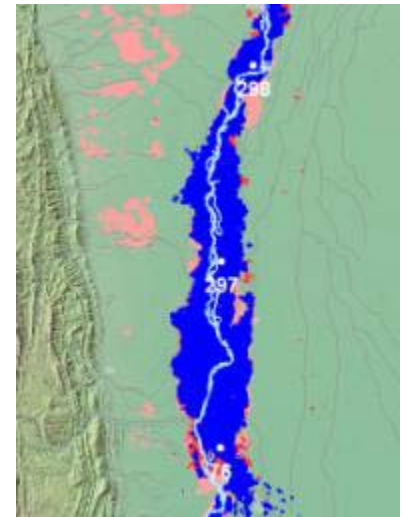


Fig. 2. MODIS Near Real Time Inundation Mapping (dark blue)

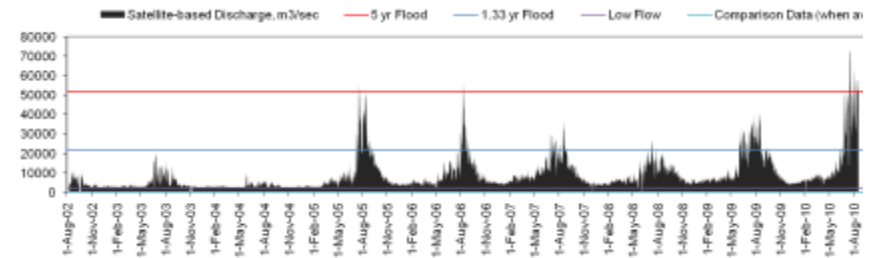


Fig. 3. AMSR-E estimated river discharge at Site 76



# Applied Sciences Program

## Example: Salmon Fisheries



CVP Stream Temperature DSS Test



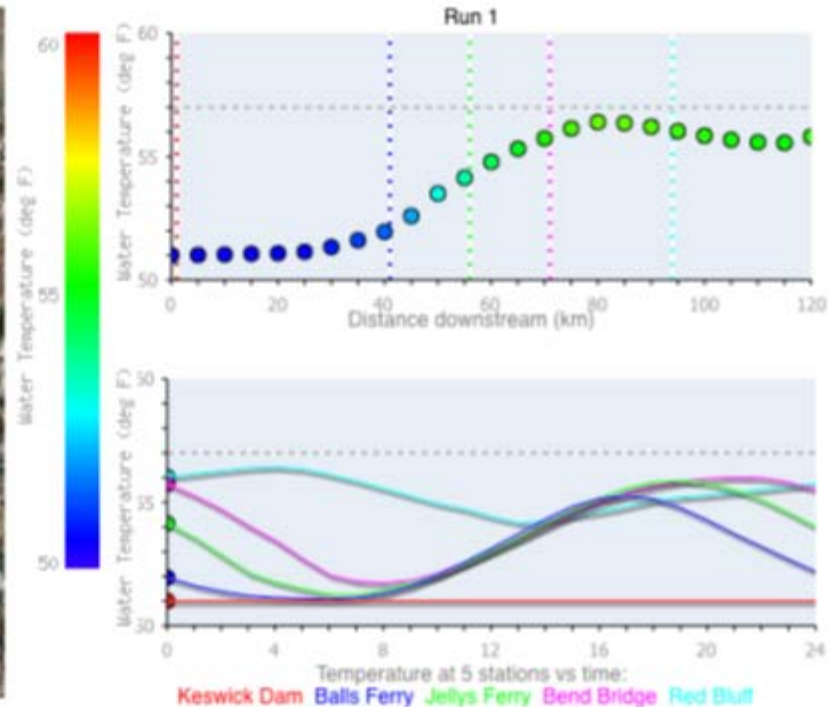
Home

Management Scenarios

Forecasts

Model Information

Links



View Run 2

(slide from UCSC/Eric Danner – PI in ROSES-07)

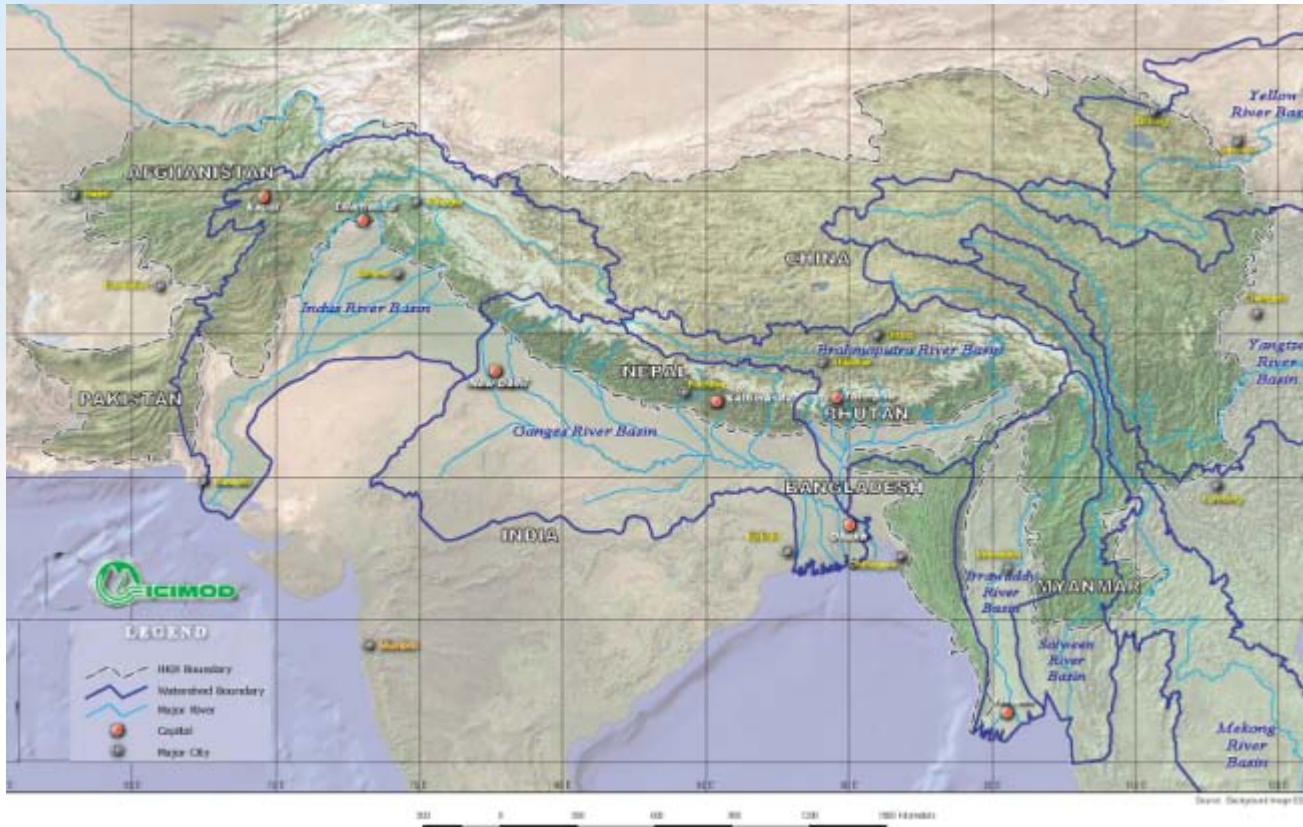




# Earth Science & Applications

## *Climate, Water Resources, and People*

### Climate Impacts on Glaciers in the Himalaya Region



- *MODIS snow water equivalent and snow cover extent products*
- *ASTER glacier identification models*
- *IPCC scenarios*
- *GFS*
- *ASTER/SRTM DEMs*
- *GeoSFM model*

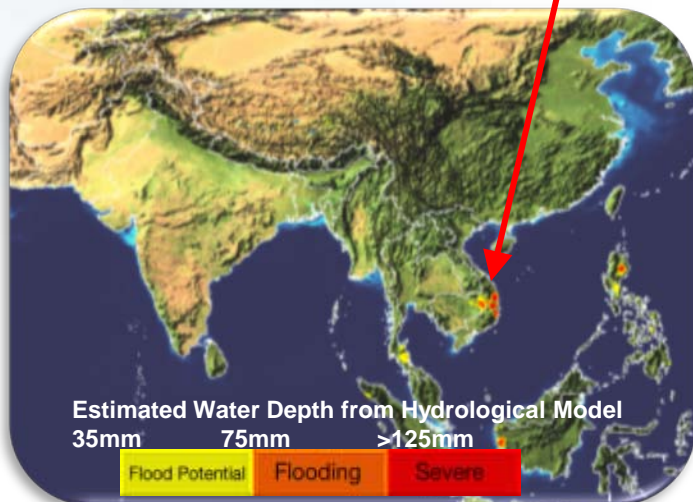
Examine impacts of climate change on water resources in Himalayan region and enhance decision making capacity for management of water resources (floods, agricultural water) in the short (snow, rainfall) and the long-term (glaciers).



# On-line Global Flood Monitoring

## Every 3 Hours at 0.25deg

<http://trmm.gsfc.nasa.gov>



*Real-time global estimation of flood areas using satellite-based rainfall and a hydrological model running globally, every three hours at 0.25°.*



- See TRMM web site for a global view of today's flood affected areas and 7-day movies of the evolution potential floods (<http://trmm.gsfc.nasa.gov/>)





# NASA VOLCANIC CLOUD DATA FOR AVIATION HAZARDS

Credit: A. Krueger, N. Krotkov (UMBC); G. Serafino (NOAA/NESDIS); M. Guffanti (USGS)

## Background

- This project has demonstrated reliable and more accurate detection of volcanic ash clouds using NASA Aura/OMI SO<sub>2</sub> data. The proven utility of this data led to its operational use at the Volcanic Ash Advisory Centers (VAAC's) in the NOAA NWS.
  - NOAA VAAC website provides direct link to the NASA products which are used operationally to formulate and validate Volcanic Ash Advisories.
  - SO<sub>2</sub> is a reliable marker for fresh ash clouds:
    - Clear discrimination between volcanic plume and clouds
    - SO<sub>2</sub> serves as clear marker of ash from explosive magmatic eruptions
    - Few large sources of SO<sub>2</sub> other than volcanic eruptions (smelters); however, locations of smelters and volcanoes are known and fixed (no false alarms).

## Recent Highlights

- NASA is now providing near real-time information on volcanic SO<sub>2</sub> and ash aerosols from Aura/OMI for the London VAAC (and other operational entities), through the NOAA VAAC website. This information had been previously available for sectors covering the Americas and the Pacific (the areas of responsibility for NOAA); however, beginning on April 19, NASA began to provide this information for sectors covering Iceland and Northwest Europe.
  - Additionally, the *Support to Aviation Control Service* (SACS) (a support center for the European VAACs) is now directly linking to the Aura/OMI near-real time data (<http://sacs.aeronomie.be/>).

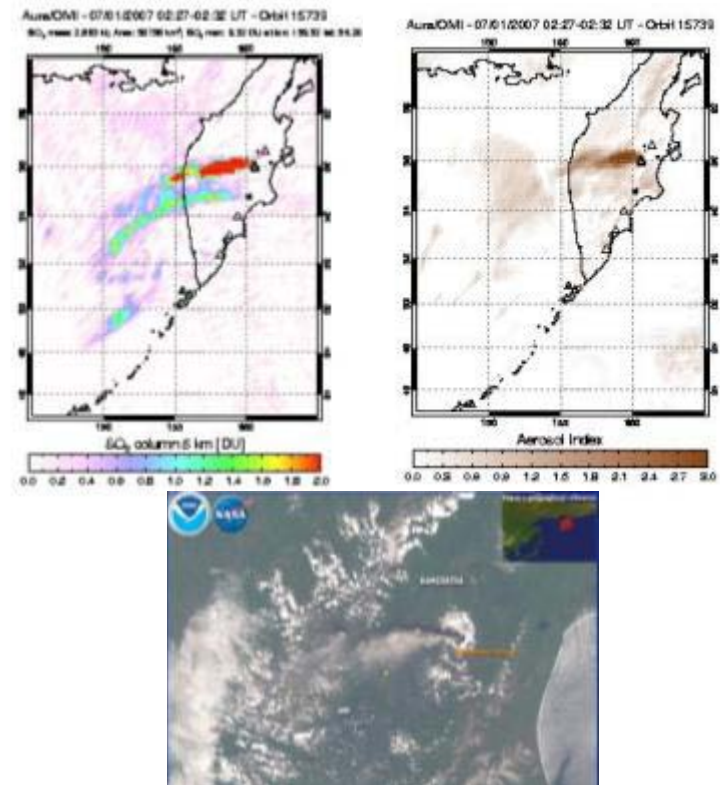


Figure 1. Comparison of OMI SO<sub>2</sub> and ash plume data with MODIS imagery from the July 1, 2007 Kamchatka eruption.

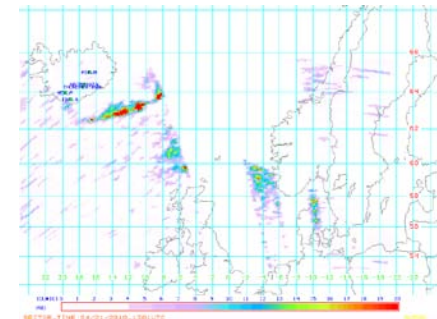
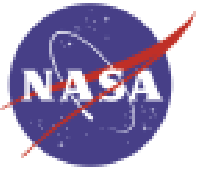


Figure 2. OMI SO<sub>2</sub> data from Iceland sector on April 21, 2010 (1301Z).





# Applied Sciences Program

## Project on Marine Fisheries

## Using Satellite Data to Reduce Bycatch of Protected Sea Turtles

*S. Bograd, NOAA NMFS*

**Highlight-** After evaluating sea surface temperatures and fishery distributions, the study showed that swordfish were found in slightly warmer temperatures than loggerhead turtles. 18.5 degrees Celsius is chosen as the Northern limit of swordfish fishing in an experimental product made available to fishers, thus helping to minimize bycatch of protected sea turtles.

**Relevance** – This is one study from a task to develop applications with NOAA fisheries managers to incorporate NASA satellite ocean data products into fisheries and marine resources management and assessment activities that will lead to decision support tools. The goal was to reduce bycatch of protected and endangered sea turtles and reduce the time-area closures of pelagic long-line fisheries. The use of satellite data help determine the environmental conditions under which turtles and fisheries may associate.

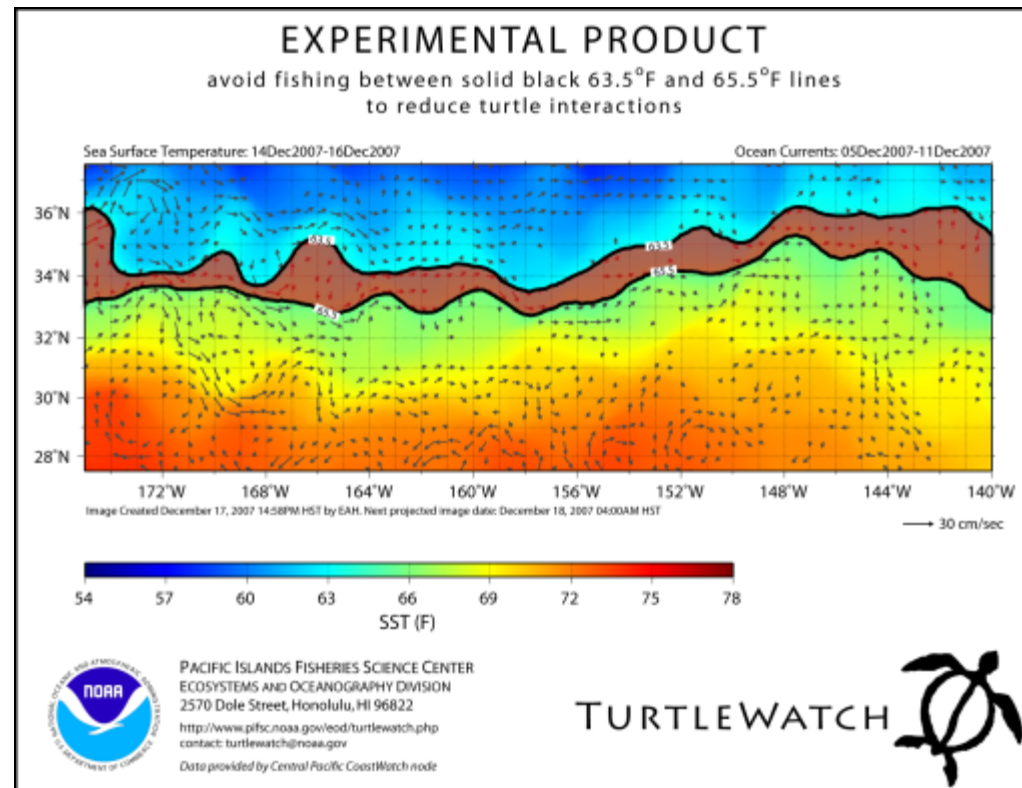
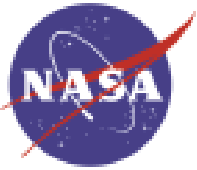


Figure above shows the experimental product given to fisherman on where to avoid fishing to reduce turtle interactions. The solid lines and simply stated temperatures provide clear guidelines.



# New Model Tool Enhances Decision Support for Biofuels and Carbon Management on US Agricultural Lands

## Highlight:

A final modeling tool, which includes NASA data in the Spatial data sets have been developed to estimate Net Ecosystem Exchange (NEE) and Net Ecosystem Carbon Balance (NECB) on each 1 km<sup>2</sup> unit of croplands in the United States. The carbon flux projections from this model are being used by both USDA and DOE, to better understand impacts of nationwide establishment of herbaceous energy crops on the carbon cycle.

## Relevance

The development of this tool was important to capability development, through economic modeling, to estimate future NEE and NECB, based on commodity markets and climate mitigation policies. By providing a tool that is actively being used by partner agencies USDA and DOE, decision making by our partners is clearly enhanced with NASA funded efforts.

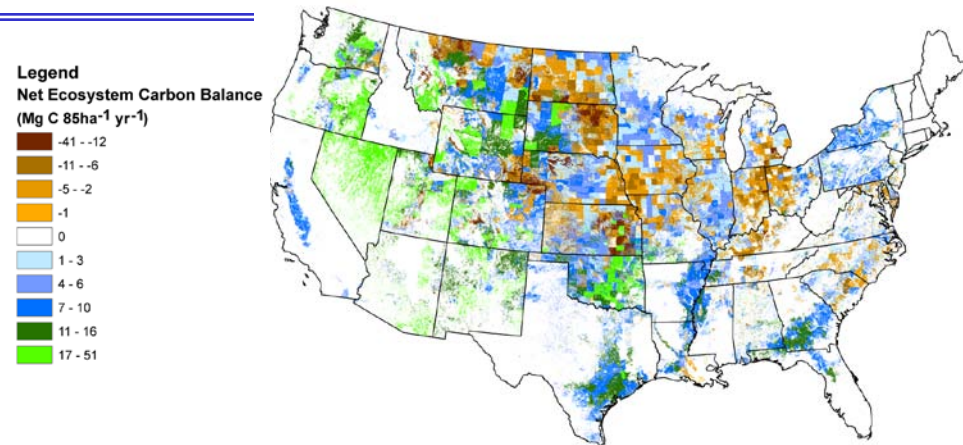


Figure 1. Direct and indirect net carbon emissions, collectively referred to as the net ecosystem carbon balance, for each ~1km cropland area in the U.S.

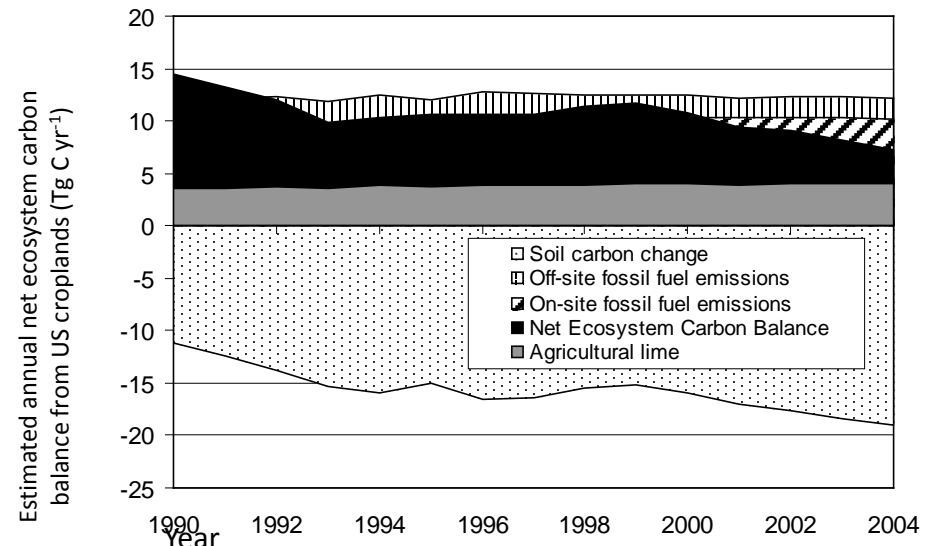


Figure 2. Plotted graph shows the variability of carbon exchange, fuel emissions and net ecosystem balance with time. This data can be tracked geospatially, as illustrated in Figure 1, above.

*Credit: Tris West, JCGRI*

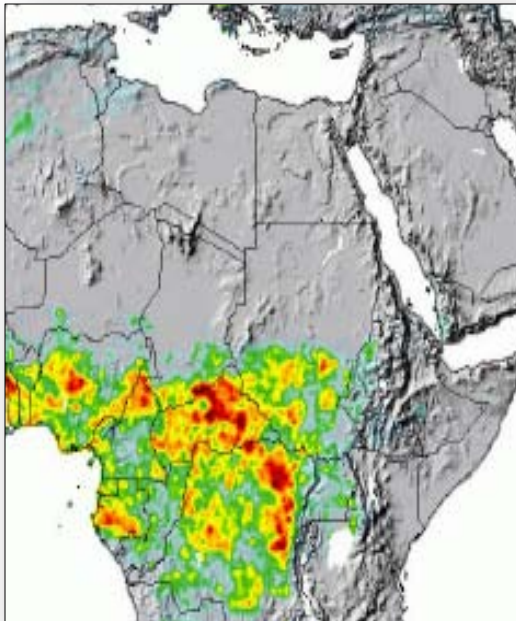
# SERVIR

*Enabling the use of earth observations and models for timely decision making to benefit society*

**Regional visualization and monitoring system**

It is a low cost system that capitalizes on existing space and ground based assets and is operated and controlled by the host nations.

SERVIR functions in five countries of East Africa and seven countries of Central America & the Dominican Republic



**Flood Forecasting in Africa**



**Training and Capacity Building**



**Mapping Fires in Guatemala Mexico**

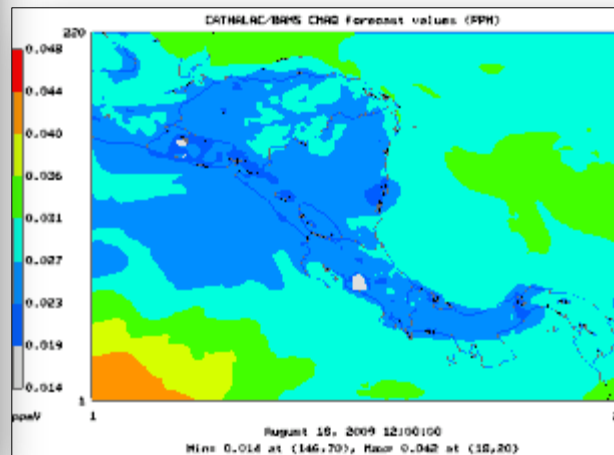


# Example SERVIR Applications

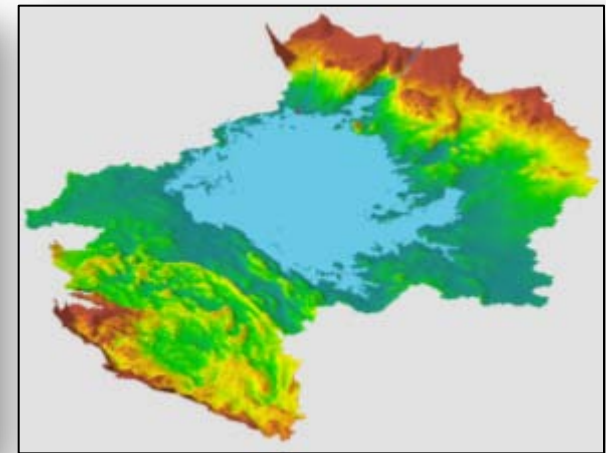
- Environmental Monitoring
- Disaster Analysis
- Air Quality and Public Health
- Climate Change and Biodiversity



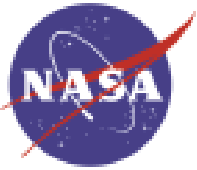
Mapping Water Quality in Guatemala



Monitoring Air Quality In Central America



Flood Modeling in the Lake Victoria Basin



# NASA-sponsored Training: Satellite Remote Sensing for Air Quality Analysis in the Himalayan Region

**Objective:** Train decision makers from government and universities in Nepal on the use of NASA satellite products for analysis of air quality and air pollution.

**Accomplishments:**

- **Conducted a 3-Day training** on 17-19 February 2010 covering the principles of satellite remote sensing and the application of NASA data and models to the monitoring and forecasting of local and transboundary air pollution in south Asia. The training was hosted by the International Centre for Integrated Mountain Development (ICIMOD). Participants included policymakers from the Nepal ministries of environment and health, research leaders from national universities, and program managers from non-governmental environmental organizations.
- **The training featured lectures and highly interactive group exercises that facilitated learning.** Topics covered included introduction to satellite remote sensing, NASA satellite products for air quality, accessing products on the Internet, event analysis through case studies, numerical air quality prediction, and communicating air quality information.
- **The products covered in presentations and hands-on activities included:**
  - MODIS True Color Imagery and MODIS Aerosol Optical Depth
  - OMI NO<sub>2</sub> (nitrogen dioxide) and other OMI products
  - Fire and smoke products such as FIRMS and HMS
  - Online tools such as GIOVANNI and The Smog Blog
- **The training was conducted under the ASP Air Quality Program Element and as part of the SERVIR expansion to Asia.**



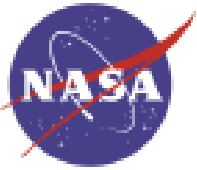
Participants learning the principles of remote sensing



Site tour of ICIMOD's air monitoring stations



Working an interactive exercise on satellite products



# ESD Applied Sciences Program

## *DEVELOP Summer 2010 Presentations*

### Summer 2010

- Awarded 114 internships across 19 projects nationwide with over 30 science advisors
- Breakdown by education level:
  - Graduate or above – 25 students
  - Undergraduate – 78 students
  - High school – 11 students

- Breakdown by location:

#### NASA Centers

LaRC: 46 students	ARC: 18 students
SSC: 8 students	GSFC: 7 students
JPL: 3 students	GSFC/WFF: 3 students

#### Partner Locations

UA-Birmingham (MSFC):	8 students
Alabama/Mobile County:	9 students
Virginia/Wise County:	12 students

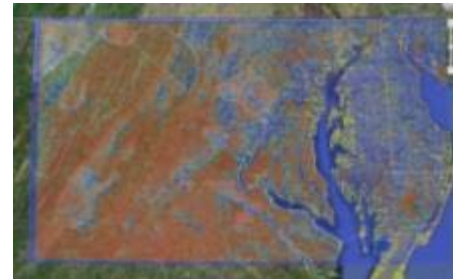
### DEVELOP History

- DEVELOP has awarded over 1,900 internship opportunities since its inception in 1998
- In a recent survey of DEVELOP graduates from 2006 - 2009, 70% are employed in STEM disciplines (183 responses)

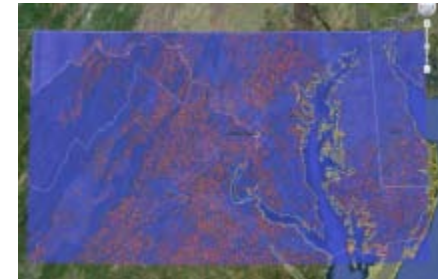
## **Maryland Invasive Species Project**

NASA's Invasive Species Forecasting System (ISFS) was utilized to create distribution maps of the highly invasive exotic grass species the Wavyleaf Basketgrass (WLBG). First detected in the US in 1996, the grass now covers over 1,000 acres of forest. Partnering with the Maryland Department of Natural Resources (MDDNR), this project's activity supports an ISFS-based decision support system prototype tailored to WLBG and the specific needs of MDDNR ecologists and resource managers. These products will provide the basis for evaluating the overall effectiveness and usability of ISFS to WLBG early detection and rapid response.

**Initial Run**



**Final Run**



**SWLR**



**MaxEnt**

